(f) The filing of an Application for Interim Waiver shall not constitute grounds for noncompliance with any requirements of this subpart, until an Interim Waiver has been granted.

(g) An Interim Waiver from test procedure requirements will be granted by the Assistant Secretary for Conservation and Renewable Energy if it is determined that the applicant will experience economic hardship if the Application for Interim Waiver is denied, if it appears likely that the Petition for Waiver will be granted, and/or the Assistant Secretary determines that it would be desirable for public policy reasons to grant immediate relief pending a determination on the Petition for Waiver.

(h) An interim waiver will terminate 180 days after issuance or upon the determination on the Petition for Waiver, whichever occurs first. An interim waiver may be extended by DOE for 180 days. Notice of such extension and/or any modification of the terms or duration of the interim waiver shall be published in the FEDERAL REGISTER, and shall be based on relevant information contained in the record and any comments received subsequent to issuance of the interim waiver.

(i) Following publication of the Petition for Waiver in the FEDERAL REGISTER, a petitioner may, within 10 working days of receipt of a copy of any comments submitted in accordance with paragraph (b)(1) of this section, submit a rebuttal statement to the Assistant Secretary for Conservation and Renewable Energy. A petitioner may rebut more than one response in a single rebuttal statement.

(j) The petitioner shall be notified in writing as soon as practicable of the disposition of each Petition for Waiver. The Assistant Secretary for Conservation and Renewable Energy shall issue a decision on the petition as soon as is practicable following receipt and review of the Petition for Waiver and other applicable documents, including, but not limited to, comments and rebuttal statements.

(k) The filing of a Petition for Waiver shall not constitute grounds for noncompliance with any requirements of this subpart, until a waiver or interim waiver has been granted.

(l) Waivers will be granted by the Assistant Secretary for Conservation and Renewable Energy, if it is determined that the basic model for which the waiver was requested contains a design characteristic which either prevents testing of the basic model according to the prescribed test procedures, or the prescribed test procedures may evaluate the basic model in a manner so unrepresentative of its true energy consumption characteristics, or water consumption characteristics (in the case of faucets, showerheads, water closets, and urinals) as to provide materially inaccurate comparative data. Waivers may be granted subject to conditions, which may include adherence to alternate test procedures specified by the Assistant Secretary for Conservation and Renewable Energy. The Assistant Secretary shall consult with the Federal Trade Commission prior to granting any waiver, and shall promptly publish in the FEDERAL REGISTER notice of each waiver granted or denied, and any limiting conditions of each waiver granted.

(m) Within one year of the granting of any waiver, the Department of Energy will publish in the FEDERAL REGISTER a notice of proposed rulemaking to amend its regulations so as to eliminate any need for the continuation of such waiver. As soon thereafter as practicable, the Department of Energy will publish in the FEDERAL REGISTER a final rule. Such waiver will terminate on the effective date of such final rule.

(n) In order to exhaust administrative remedies, any person aggrieved by an action under this section must file an appeal with the DOE's Office of Hearings and Appeals as provided in 10 CFR part 1003, subpart C.

[51 FR 42826, Nov. 26, 1986, as amended at 60 FR 15017, Mar. 21, 1995; 63 FR 13316, Mar. 18, 1998; 76 FR 12502, Mar. 7, 2011]

APPENDIX A TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF ELECTRIC REFRIGERATORS AND ELECTRIC REFRIGERATOR-FREEZERS

The provisions of appendix A shall apply to all products manufactured on or after the effective date of any amended standards promulgated by DOE pursuant to Section

325(b)(4) of the Energy Policy and Conservation Act of 1975, as amended by the Energy Independence and Security Act of 2007 (to be codified at 42 U.S.C. 6295(b)(4)).

1. Definitions

Section 3, *Definitions*, of HRF–1–2008 (incorporated by reference; see §430.3) applies to this test procedure.

1.1 ''Adjusted total volume'' means the sum of:

(i) The fresh food compartment volume as defined in HRF–1–2008 (incorporated by reference; see §430.3) in cubic feet, and

(ii) The product of an adjustment factor and the net freezer compartment volume as defined in HRF–1–2008 in cubic feet.

1.2 ''All-refrigerator'' means an electric refrigerator that does not include a compartment for the freezing and long time storage of food at temperatures below 32 °F (0.0 °C). It may include a compartment of 0.50 cubic-foot capacity (14.2 liters) or less for the freezing and storage of ice.

1.3 ''Anti-sweat heater'' means a device incorporated into the design of a refrigerator or refrigerator-freezer to prevent the accumulation of moisture on the exterior or interior surfaces of the cabinet.

1.4 ''Anti-sweat heater switch'' means a user-controllable switch or user interface which modifies the activation or control of anti-sweat heaters.

1.5 ''Automatic defrost'' means a system in which the defrost cycle is automatically initiated and terminated, with resumption of normal refrigeration at the conclusion of the defrost operation. The system automatically prevents the permanent formation of frost on all refrigerated surfaces. Nominal refrigerated food temperatures are maintained during the operation of the automatic defrost system.

1.6 ''Automatic icemaker'' means a device, that can be supplied with water without user intervention, either from a pressurized water supply system or by transfer from a water reservoir located inside the cabinet, that automatically produces, harvests, and stores ice in a storage bin, with means to automatically interrupt the harvesting operation when the ice storage bin is filled to a pre-determined level.

1.7 ''Cycle'' means the period of 24 hours for which the energy use of an electric refrigerator or electric refrigerator-freezer is calculated as though the consumer activated compartment temperature controls were set to maintain the standardized temperatures (see section 3.2).

1.8 ''Cycle type'' means the set of test conditions having the calculated effect of operating an electric refrigerator or electric refrigerator-freezer for a period of 24 hours, with the consumer activated controls other than those that control compartment temperatures set to establish various operating characteristics.

1.9 ''Defrost cycle type'' means a distinct sequence of control whose function is to remove frost and/or ice from a refrigerated surface. There may be variations in the defrost control sequence such as the number of defrost heaters energized. Each such variation establishes a separate distinct defrost cycle type. However, defrost achieved regularly during the compressor off-cycles by warming of the evaporator without active heat addition is not a defrost cycle type.

1.10 ''Externally vented refrigerator or refrigerator-freezer'' means an electric refrigerator or electric refrigerator-freezer that has an enclosed condenser or an enclosed condenser/compressor compartment and a set of air ducts for transferring the exterior air from outside the building envelope into, through, and out of the refrigerator or refrigerator-freezer cabinet; is capable of mixing exterior air with the room air before discharging into, through, and out of the condenser or condenser/compressor compartment; may include thermostatically controlled dampers or controls that mix the exterior and room air at low outdoor temperatures and exclude exterior air when the outdoor air temperature is above 80 °F (26.7 °C) or the room air temperature; and may have a thermostatically actuated exterior air fan.

1.11 ''HRF–1–2008'' means AHAM Standard HRF–1–2008, Association of Home Appliance Manufacturers, Energy and Internal Volume of Refrigerating Appliances (2008), including Errata to Energy and Internal Volume of Refrigerating Appliances, Correction Sheet issued November 17, 2009. Only sections of HRF–1–2008 (incorporated by reference; see §430.3) specifically referenced in this test procedure are part of this test procedure. In cases where there is a conflict, the language of the test procedure in this appendix takes precedence over HRF–1–2008.

1.12 ''Long-time automatic defrost'' means an automatic defrost system whose successive defrost cycles are separated by 14 hours or more of compressor operating time.

1.13 ''Separate auxiliary compartment'' means a freezer compartment or a fresh food compartment of a refrigerator or refrigerator-freezer having more than two compartments that is not the first freezer compartment or the first fresh food compartment. Access to a separate auxiliary compartment is through a separate exterior door or doors rather than through the door or doors of another compartment. Separate auxiliary compartments may be convertible (e.g., from fresh food to freezer). Separate auxiliary freezer compartments may not be larger than the first freezer compartment and separate auxiliary fresh food compartments may not be larger than the first fresh food compartment, but such size restrictions do not apply to separate auxiliary convertible compartments.

1.14 "Special compartment" means any compartment other than a butter conditioner, without doors directly accessible from the exterior, and with separate temperature control (such as crispers convertible to meat keepers) that is not convertible from fresh food temperature range to freezer temperature range.

1.15 "Stabilization period" means the total period of time during which steady-state conditions are being attained or evaluated.

1.16 "Standard cycle" means the cycle type in which the anti-sweat heater control, when provided, is set in the highest energy-consuming position.

1.17 "Variable anti-sweat heater control" means an anti-sweat heater control that varies the average power input of the anti-sweat heater(s) based on operating condition variable(s) and/or ambient condition variable(s).

1.18 "Variable defrost control" means an automatic defrost system in which successive defrost cycles are determined by an operating condition variable or variables other than solely compressor operating time. This includes any electrical or mechanical device performing this function. A control scheme that changes the defrost interval from a fixed length to an extended length (without any intermediate steps) is not considered a variable defrost control. A variable defrost control feature should predict the accumulation of frost on the evaporator and react accordingly. Therefore, the times between defrost should vary with different usage patterns and include a continuum of lengths of time between defrosts as inputs vary.

2. Test Conditions

2.1 Ambient Temperature. The ambient temperature shall be 90.0 ±1 °F (32.2 ±0.6 °C) during the stabilization period and the test period.

2.2 Operational Conditions. The electric refrigerator or electric refrigerator-freezer shall be installed and its operating conditions maintained in accordance with HRF–1–2008, (incorporated by reference; see § 430.3), section 5.3 through section 5.5.5.5 (excluding section 5.5.5.4). Exceptions and clarifications to the cited sections of HRF–1–2008 are noted in sections 2.3 through 2.8, and 5.1 of this test procedure.

2.3 Anti-Sweat Heaters. The anti-sweat heater switch is to be on during one test and off during a second test. In the case of an electric refrigerator-freezer equipped with variable anti-sweat heater control, the standard cycle energy use shall be the result of the calculation described in 6.2.3.

2.4 Conditions for Automatic Defrost Refrigerator-Freezers. For automatic defrost refrigerator-freezers, the freezer compartments shall not be loaded with any frozen food packages during testing. Cylindrical metallic masses of dimensions 1.12 ±0.25 inches (2.9 ±0.6 cm) in diameter and height shall be attached in good thermal contact with each temperature sensor within the refrigerated compartments. All temperature measuring sensor masses shall be supported by low-thermal-conductivity supports in such a manner to ensure that there will be at least 1 inch (2.5 cm) of air space separating the thermal mass from contact with any interior surface or hardware inside the cabinet. In case of interference with hardware at the sensor locations specified in section 5.1, the sensors shall be placed at the nearest adjacent location such that there will be a 1-inch air space separating the sensor mass from the hardware.

2.5 Conditions for All-Refrigerators. There shall be no load in the freezer compartment during the test.

2.6 The cabinet and its refrigerating mechanism shall be assembled and set up in accordance with the printed consumer instructions supplied with the cabinet. Set-up of the refrigerator or refrigerator-freezer shall not deviate from these instructions, unless explicitly required or allowed by this test procedure. Specific required or allowed deviations from such set-up include the following:

(a) Connection of water lines and installation of water filters are not required;

(b) Clearance requirements from surfaces of the product shall be as described in section 2.8 of this appendix;

(c) The electric power supply shall be as described in HRF–1–2008 (incorporated by reference; see § 430.3), section 5.5.1;

(d) Temperature control settings for testing shall be as described in section 3 below. Settings for convertible compartments and other temperature-controllable or special compartments shall be as described in section 2.7 of this appendix;

(e) The product does not need to be anchored or otherwise secured to prevent tipping during energy testing;

(f) All the product's chutes and throats required for the delivery of ice shall be free of packing, covers, or other blockages that may be fitted for shipping or when the icemaker is not in use; and

(g) Ice storage bins shall be emptied of ice.

For cases in which set-up is not clearly defined by this test procedure, manufacturers must submit a petition for a waiver (see section 7).

2.7 Compartments that are convertible (e.g., from fresh food to freezer) shall be operated in the highest energy use position. For the special case of convertible separate auxiliary compartments, this means that the compartment shall be treated as a freezer compartment or a fresh food compartment, depending on which of these represents higher energy use. Special compartments shall be tested with controls set to provide the coldest temperature. However, for special compartments in which temperature control is achieved using the addition of heat (including resistive electric heating, refrigeration system waste heat, or heat from any other source, but excluding the transfer of air from another part of the interior of the product) for any part of the controllable temperature range of that compartment, the product energy use shall be determined by averaging two sets of tests. The first set of tests shall be conducted with such special compartments at their coldest settings, and the second set of tests shall be conducted with such special compartments at their warmest settings. The requirements for the warmest or coldest temperature settings of this section do not apply to features or functions associated with temperature control (such as fast chill compartments) that are initiated manually and terminated automatically within 168 hours.

2.8 The space between the back of the cabinet and a vertical surface (the test room wall or simulated wall) shall be the minimum distance in accordance with the manufacturer's instructions. However, the clearance shall not be greater than 2 inches (51 mm) from the plane of the cabinet's back panel to the vertical surface. If permanent rear spacers extend further than this distance, the appliance shall be located with the spacers in contact with the vertical surface.

2.9 Steady-State Condition. Steady-state conditions exist if the temperature measurements in all measured compartments taken at 4-minute intervals or less during a stabilization period are not changing at a rate greater than 0.042 °F (0.023 °C) per hour as determined by the applicable condition of A or B, described below.

A. The average of the measurements during a 2-hour period if no cycling occurs or during a number of complete repetitive compressor cycles occurring through a period of no less than 2 hours is compared to the average over an equivalent time period with 3 hours elapsing between the two measurement periods.

B. If A above cannot be used, the average of the measurements during a number of complete repetitive compressor cycles occurring through a period of no less than 2 hours and including the last complete cycle before a defrost period (or if no cycling occurs, the average of the measurements during the last 2 hours before a defrost period) are compared to the same averaging period before the following defrost period.

2.10 Exterior Air for Externally Vented Refrigerator or Refrigerator-Freezer. An exterior air source shall be provided with adjustable temperature and pressure capabilities. The exterior air temperature shall be adjustable from 30 ±1 °F (1.7 ±0.6 °C) to 90 ±1 °F (32.2 ±0.6 °C).

2.10.1 Air Duct. The exterior air shall pass from the exterior air source to the test unit through an insulated air duct.

2.10.2 Air Temperature Measurement. The air temperature entering the condenser or condenser/compressor compartment shall be maintained to ±3 °F (1.7 °C) during the stabilization and test periods and shall be measured at the inlet point of the condenser or condenser/compressor compartment (''condenser inlet''). Temperature measurements shall be taken from at least three temperature sensors or one sensor per 4 square inches (25.8 square cm) of the air duct cross-sectional area, whichever is greater, and shall be averaged. For a unit that has a condenser air fan, a minimum of three temperature sensors at the condenser fan discharge shall be required. Temperature sensors shall be arranged to be at the centers of equally divided cross-sectional areas. The exterior air temperature, at its source, shall be measured and maintained to ±1 °F (0.6 °C) during the test period. The temperature measuring devices shall have an error no greater than ±0.5 °F (±0.3 °C). Measurements of the air temperature during the test period shall be taken at regular intervals not to exceed 4 minutes.

2.10.3 Exterior Air Static Pressure. The exterior air static pressure at the inlet point of the unit shall be adjusted to maintain a negative pressure of 0.20″ ±0.05″ water column (62 Pascals ±12.5 Pascals) for all air flow rates supplied to the unit. The pressure sensor shall be located on a straight duct with a distance of at least 7.5 times the diameter of the duct upstream and a distance of at least 3 times the diameter of the duct downstream. There shall be four static pressure taps at 90° angles apart. The four pressures shall be averaged by interconnecting the four pressure taps. The air pressure measuring instrument shall have an error no greater than 0.01'' water column (2.5 Pascals).

3. Test Control Settings

3.1 Model with no User Operable Temperature Control. A test shall be performed to measure the compartment temperatures and energy use. A second test shall be performed with the temperature control electrically short circuited to cause the compressor to run continuously.

3.2 Models with User Operable Temperature Control. Testing shall be performed in accordance with one of the following sections using the following standardized temperatures:

All-Refrigerator: 39 °F (3.9 °C) fresh food compartment temperature;

Refrigerator: 15 °F (−9.4 °C) freezer compartment temperature, 39 °F (3.9 °C) fresh food compartment temperature;

Refrigerator-Freezer: 0 °F (−17.8 °C) freezer compartment temperature, 39 °F (3.9 °C) fresh food compartment temperature.

For the purposes of comparing compartment temperatures with standardized temperatures, as described in sections 3.2.1 and 3.2.2, the freezer compartment temperature shall be as specified in section 5.1.4, and the fresh food compartment temperature shall be as specified in section 5.1.3.

3.2.1 A first test shall be performed with all compartment temperature controls set at their median position midway between their warmest and coldest settings. For mechanical control systems, knob detents shall be mechanically defeated if necessary to attain a median setting. For electronic control systems, the test shall be performed with all compartment temperature controls set at the average of the coldest and warmest settings—if there is no setting equal to this average, the setting closest to the average shall be used. If there are two such settings equally close to the average, the higher of these temperature control settings shall be used. A second test shall be performed with all controls set at their warmest setting or all controls set at their coldest setting (not electrically or mechanically bypassed). For all-refrigerators, this setting shall be the appropriate setting that attempts to achieve compartment temperatures measured during the two tests which bound (i.e., one is above and one is below) the standardized temperature for all-refrigerators. For refrigerators and refrigerator-freezers, the second test shall be conducted with all controls at their coldest setting, unless all compartment temperatures measured during the first part of the test are lower than the standardized temperatures, in which case the second test shall be conducted with all controls at their warmest setting. Refer to Table 1 for all-refrigerators or Table 2 for refrigerators with freezer compartments and refrigerator-freezers to determine which test results to use in the energy consumption calculation. If any compartment is warmer than its standardized temperature for a test with all controls at their coldest position, the tested unit fails the test and cannot be rated.

TABLE 1—TEMPERATURE SETTINGS FOR ALL-REFRIGERATORS

First test		Second test		Energy calculation based on:
Settings	Results	Settings	Results	
Mid	Low	Warm	Low	Second Test Only.
			High	First and Second Tests.
	High	Cold	Low	First and Second Tests.
			High	No Energy Use Rating.

TABLE 2—TEMPERATURE SETTINGS FOR REFRIGERATORS WITH FREEZER COMPARTMENTS AND REFRIGERATOR-FREEZERS

First test		Second test		Energy calculation based on:
Settings	Results	Settings	Results	
Fzr Mid FF Mid	Fzr Low FF Low	Fzr Warm FF Warm	Fzr Low FF Low	Second Test Only.
			Fzr Low FF High	First and Second Tests.
			Fzr High FF Low	First and Second Tests.
			Fzr High FF High	First and Second Tests.
	Fzr Low FF High	Fzr Cold FF Cold	Fzr Low FF High	No Energy Use Rating.
			Fzr Low FF Low	First and Second Tests.
	Fzr High FF Low	Fzr Cold FF Cold	Fzr High FF Low	No Energy Use Rating.
			Fzr Low FF Low	First and Second Tests.
	Fzr High FF High	Fzr Cold FF Cold	Fzr Low FF Low	First and Second Tests.
			Fzr Low FF High	No Energy Use Rating.
			Fzr High FF Low	No Energy Use Rating.
			Fzr High FF High	No Energy Use Rating.

Notes: Fzr = Freezer Compartment, FF = Fresh Food Compartment.

3.2.2 Alternatively, a first test may be performed with all temperature controls set at their warmest setting. If all compartment temperatures are below the appropriate standardized temperatures, then the result of this test alone will be used to determine energy consumption. If this condition is not met, then the unit shall be tested in accordance with 3.2.1.

3.2.3 Temperature Settings for Separate Auxiliary Convertible Compartments. For separate auxiliary convertible compartments tested as freezer compartments, the median setting shall be within 2 °F (1.1 °C) of the standardized temperature, and the warmest setting shall be above 5 °F (−15 °C). For separate auxiliary convertible compartments tested as fresh food compartments, the median setting shall be within 2 °F (1.1 °C) of the standardized temperature, and the coldest setting shall be below 34 °F (1.1 °C). For compartments where control settings are not expressed as particular temperatures, the measured temperature of the convertible compartment rather than the settings shall meet the specified criteria.

4. Test Period

Tests shall be performed by establishing the conditions set forth in section 2, and using the control settings set forth in section 3.

4.1 Nonautomatic Defrost. If the model being tested has no automatic defrost system, the test time period shall start after steady-state conditions have been achieved and be no less than 3 hours in duration. During the test period, the compressor motor shall complete two or more whole compressor cycles. (A compressor cycle is a complete ''on'' and a complete ''off'' period of the motor). If no ''off'' cycling will occur, as determined during the stabilization period, the test period shall be 3 hours. If incomplete cycling occurs (i.e. less than two compressor cycles during a 24-hour period), the results of the 24-hour period shall be used.

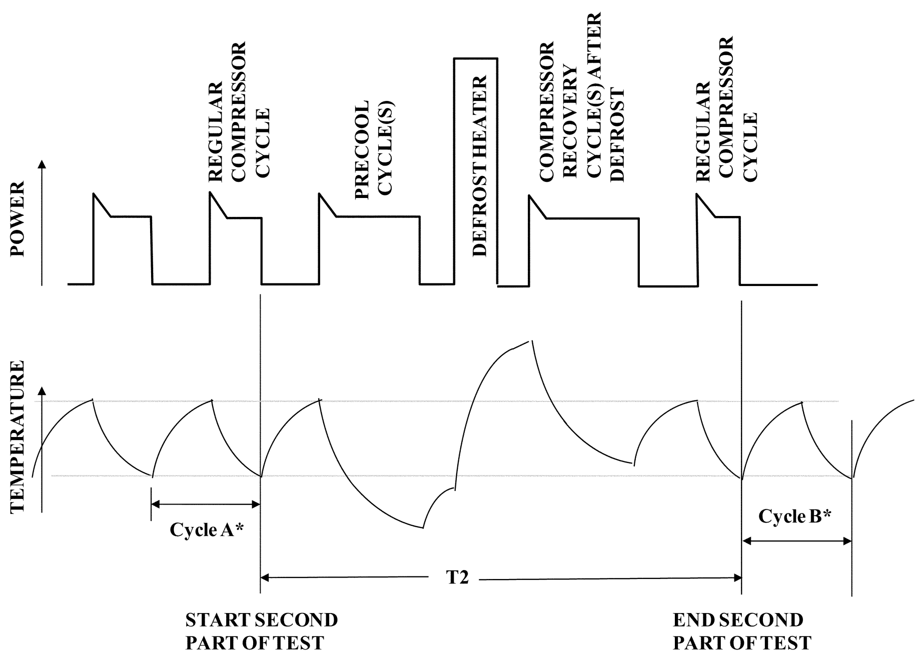
4.2 Automatic Defrost. If the model being tested has an automatic defrost system, the test time period shall start after steady-state conditions have been achieved and be from one point during a defrost period to the same point during the next defrost period. If the model being tested has a long-time automatic defrost system, the alternative provisions of 4.2.1 may be used. If the model being tested has a variable defrost control, the provisions of section 4.2.2 shall apply. If the model has a dual compressor system with automatic defrost for both systems, the provisions of 4.2.3 shall apply. If the model being tested has long-time automatic or variable defrost control involving multiple defrost cycle types, such as for a product with a single compressor and two or more evaporators in which the evaporators are defrosted at different frequencies, the provisions of section 4.2.4 shall apply. If the model being tested has multiple defrost cycle types for which compressor run time between defrosts is a fixed time of less than 14 hours for all such cycle types, and for which the compressor run time between defrosts for different defrost cycle types are equal to or multiples of each other, the test time period shall be from one point of the defrost cycle type with the longest compressor run time between defrosts to the same point during the next occurrence of this defrost cycle type. For such products not using the section 4.2.4 procedures, energy consumption shall be calculated as described in section 5.2.1.1.

4.2.1 Long-time Automatic Defrost. If the model being tested has a long-time automatic defrost system, the two-part test described in this section may be used. The first part is a stable period of compressor operation that includes no portions of the defrost cycle, such as precooling or recovery, that is otherwise the same as the test for a unit having no defrost provisions (section 4.1). The second part is designed to capture the energy consumed during all of the events occurring with the defrost control sequence that are outside of stable operation.

4.2.1.1 Cycling Compressor System. For a system with a cycling compressor, the second part of the test starts at the termination of the last regular compressor ''on'' cycle. The average temperatures of the fresh food and freezer compartments measured from the termination of the previous compressor ''on'' cycle to the termination of the last regular compressor ''on'' cycle must both be within 0.5 °F (0.3 °C) of their average temperatures measured for the first part of the test. If any compressor cycles occur prior to the defrost heater being energized that cause the average temperature in either compartment to deviate from its average temperature for the first part of the test by more than 0.5 °F (0.3 °C), these compressor cycles are not considered regular compressor cycles and must be included in the second part of the test. As an example, a ''precooling'' cycle, which is an extended compressor cycle that lowers the temperature(s) of one or both compartments prior to energizing the defrost heater, must be included in the second part of the test. The test period for the second part of the test ends at the termination of the first regular compressor ''on'' cycle after both compartment temperatures have fully recovered to their stable conditions. The average temperatures of the compartments measured from this termination of the first regular compressor ''on'' cycle until the termination of the next regular compressor ''on'' cycle must both be within 0.5 °F (0.3 °C) of their average temperatures measured for the first part of the test. See Figure 1.

Figure 1

Long-time Automatic Defrost Diagram for Cycling Compressors

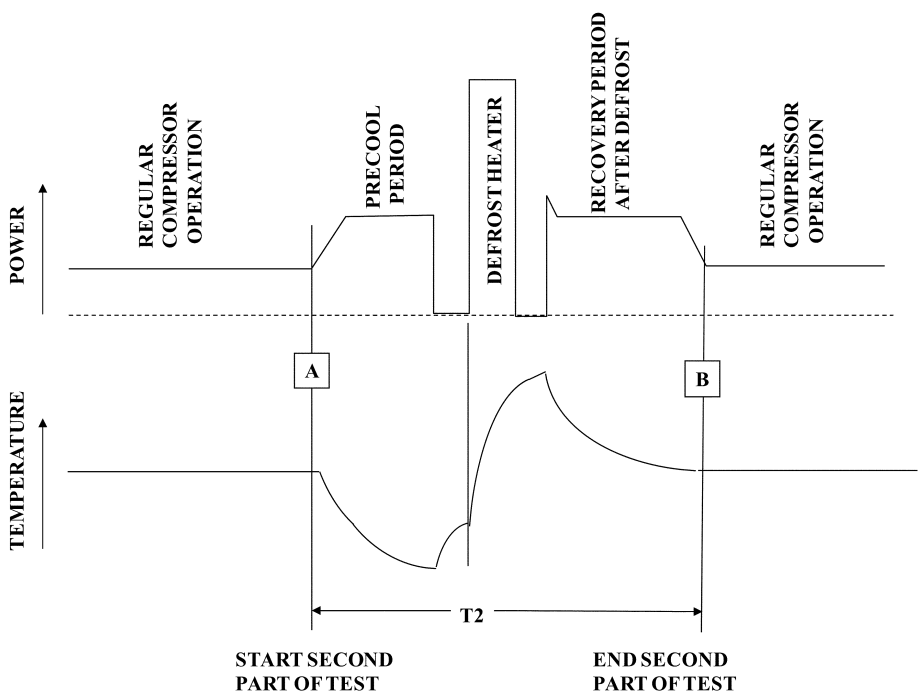


***Average compartment temperature(s) during cycles A & B must be within 0.5 ˚F of the average temperature(s) for the first part of the test.**

4.2.1.2 Non-cycling Compressor System. For a system with a non-cycling compressor, the second part of the test starts at a time before defrost during stable operation when the temperatures of both fresh food and freezer compartments are within 0.5 °F (0.3 °C) of their average temperatures measured for the first part of the test. The second part stops at a time after defrost during stable operation when the temperatures of both compartments are within 0.5 °F (0.3 °C) of their average temperatures measured for the first part of the test. See Figure 2.

Figure 2

Long-time Automatic Defrost Diagram for Non-Cycling Compressors



***Average compartment temperature(s) at times A & B must be within 0.5 ˚F of the average temperature(s) for the first part of the test.**

4.2.2 Variable Defrost Control. If the model being tested has a variable defrost control system, the test shall consist of the same two parts as the test for long-time automatic defrost (section 4.2.1).

4.2.3 Dual Compressor Systems with Automatic Defrost. If the model being tested has separate compressor systems for the refrigerator and freezer sections, each with its own automatic defrost system, then the two-part method in 4.2.1 shall be used. The second part of the method will be conducted separately for each automatic defrost system. The components (compressor, fan motors, defrost heaters, anti-sweat heaters, etc.) associated with each system will be identified and their energy consumption will be separately measured during each test.

4.2.4 Systems with Multiple Defrost Frequencies. This section applies to models with long-time automatic or variable defrost control with multiple defrost cycle types, such as models with single compressors and multiple evaporators in which the evaporators have different defrost frequencies. The two-part method in 4.2.1 shall be used. The second part of the method will be conducted separately for each distinct defrost cycle type.

5. Test Measurements

5.1 Temperature Measurements. Temperature measurements shall be made at the locations prescribed in Figures 5.1 and 5.2 of HRF–1–2008 (incorporated by reference; *see* § 430.3) and shall be accurate to within ±0.5 °F (0.3 °C). No freezer temperature measurements need be taken in an all-refrigerator model.

If the interior arrangements of the cabinet do not conform with those shown in Figure 5.1 and 5.2 of HRF–1–2008, the product may be tested by relocating the temperature sensors from the locations specified in the figures to avoid interference with hardware or components within the cabinet, in which case the specific locations used for the temperature sensors shall be noted in the test data records maintained by the manufacturer in accordance with 10 CFR 429.14, and the certification report shall indicate that non-standard sensor locations were used.

5.1.1 Measured Temperature. The measured temperature of a compartment is to be the average of all sensor temperature readings taken in that compartment at a particular point in time. Measurements shall be taken at regular intervals not to exceed 4 minutes.

5.1.2 Compartment Temperature. The compartment temperature for each test period shall be an average of the measured temperatures taken in a compartment during the test period as defined in section 4. For long-time automatic defrost models, compartment temperatures shall be those measured in the first part of the test period specified in section 4.2.1. For models with variable defrost controls, compartment temperatures shall be those measured in the first part of the test period specified in section 4.2.2.

5.1.3 Fresh Food Compartment Temperature. The fresh food compartment temperature shall be calculated as:

$$TR = \frac{\sum_{i=1}^{R}(TR_i) \times (VR_i)}{\sum_{i=1}^{R}(VR_i)}$$

Where:

R is the total number of applicable fresh food compartments, which include the first fresh food compartment and any number of separate auxiliary fresh food compartments (including separate auxiliary convertible compartments tested as fresh food compartments in accordance with section 2.7);

TR_i is the compartment temperature of fresh food compartment "i" determined in accordance with section 5.1.2; and

VR_i is the volume of fresh food compartment "i".

5.1.4 Freezer Compartment Temperature. The freezer compartment temperature shall be calculated as:

$$TF = \frac{\sum_{i=1}^{F}(TF_i) \times (VF_i)}{\sum_{i=1}^{F}(VF_i)}$$

Where:

F is the total number of applicable freezer compartments, which include the first freezer compartment and any number of separate auxiliary freezer compartments (including separate auxiliary convertible compartments tested as freezer compartments in accordance with section 2.7);

TF_i is the compartment temperature of freezer compartment "i" determined in accordance with section 5.1.2; and

VF_i is the volume of freezer compartment "i".

5.2 Energy Measurements

5.2.1 Per-Day Energy Consumption. The energy consumption in kilowatt-hours per day, ET, for each test period shall be the energy expended during the test period as specified in section 4 adjusted to a 24-hour period. The adjustment shall be determined as follows.

5.2.1.1 Nonautomatic and Automatic Defrost Models. The energy consumption in kilowatt-hours per day shall be calculated equivalent to:

$ET = EP \times 1440/T$

Where:

ET = test cycle energy expended in kilowatt-hours per day;

EP = energy expended in kilowatt-hours during the test period;

T = length of time of the test period in minutes; and

1440 = conversion factor to adjust to a 24-hour period in minutes per day.

5.2.1.2 Long-time Automatic Defrost. If the two-part test method is used, the energy consumption in kilowatt-hours per day shall be calculated equivalent to:

$ET = (1440 \times EP1/T1) + (EP2 - (EP1 \times T2/T1)) \times (12/CT)$

Where:

ET and 1440 are defined in 5.2.1.1;

EP1 = energy expended in kilowatt-hours during the first part of the test;

EP2 = energy expended in kilowatt-hours during the second part of the test;

T1 and T2 = length of time in minutes of the first and second test parts respectively;

CT = defrost timer run time or compressor run time between defrosts in hours required to cause it to go through a complete cycle, rounded to the nearest tenth of an hour; and

12 = factor to adjust for a 50-percent run time of the compressor in hours per day.

5.2.1.3 Variable Defrost Control. The energy consumption in kilowatt-hours per day shall be calculated equivalent to:

$ET = (1440 \times EP1/T1) + (EP2 - (EP1 \times T2/T1)) \times (12/CT)$,

Where:

1440 is defined in 5.2.1.1 and EP1, EP2, T1, T2, and 12 are defined in 5.2.1.2;

$CT = (CT_L \times CT_M)/(F \times (CT_M - CT_L) + CT_L)$;

CT_L = least or shortest compressor run time between defrosts in hours rounded to the nearest tenth of an hour (greater than or equal to 6 but less than or equal to 12 hours);

CT_M = maximum compressor run time between defrosts in hours rounded to the nearest tenth of an hour (greater than CT_L but not more than 96 hours);

F = ratio of per day energy consumption in excess of the least energy and the maximum difference in per-day energy consumption and is equal to 0.20.

For variable defrost models with no values for CT_L and CT_M in the algorithm, the default values of 6 and 96 shall be used, respectively.

5.2.1.4 Dual Compressor Systems with Dual Automatic Defrost. The two-part test method in section 4.2.4 must be used, and the energy consumption in kilowatt-hours per day shall be calculated equivalent to:

$ET = (1440 \times EP1/T1) + (EP2_F - (EP_F \times T2/T1)) \times (12/CT_F) + (EP2_R - (EP_R \times T3/T1)) \times (12/CT_R)$

Where:

1440, EP1, T1, EP2, 12, and CT are defined in 5.2.1.2;

EP_F = freezer system energy in kilowatt-hours expended during the first part of the test;

$EP2_F$ = freezer system energy in kilowatt-hours expended during the second part of the test for the freezer system;

EP_R = refrigerator system energy in kilowatt-hours expended during the first part of the test;

$EP2_R$ = refrigerator system energy in kilowatt-hours expended during the second part of the test for the refrigerator system;

T2 and T3 = length of time in minutes of the second test part for the freezer and refrigerator systems respectively;

CT_F = compressor run time between freezer defrosts (in hours rounded to the nearest tenth of an hour); and

CT_R = compressor run time between refrigerator defrosts (in hours rounded to the nearest tenth of an hour).

5.2.1.5 Long-time or Variable Defrost Control for Systems with Multiple Defrost cycle Types. The energy consumption in kilowatt-hours per day shall be calculated equivalent to:

$$ET = (1440 \times EP1/T1) + \sum_{i=1}^{D}\left[\left(EP2_i - (EP1 \times T2_i/T1)\right) \times (12/CT_i)\right]$$

Where:

1440 is defined in 5.2.1.1 and EP1, T1, and 12 are defined in 5.2.1.2;

i is a variable that can equal 1, 2, or more that identifies the distinct defrost cycle types applicable for the refrigerator or refrigerator-freezer;

$EP2_i$ = energy expended in kilowatt-hours during the second part of the test for defrost cycle type i;

$T2_i$ = length of time in minutes of the second part of the test for defrost cycle type i;

CT_i is the compressor run time between instances of defrost cycle type i, for long-time automatic defrost control equal to a fixed time in hours rounded to the nearest tenth of an hour, and for variable defrost control equal to

$(CT_{Li} \times CT_{Mi})/(F \times (CT_{Mi} - CT_{Li}) + CT_{Li})$;

CT_{Li} = least or shortest compressor run time between instances of defrost cycle type i in hours rounded to the nearest tenth of an hour (CT_L for the defrost cycle type with the longest compressor run time between defrosts must be greater than or equal to 6 but less than or equal to 12 hours);

CT_{Mi} = maximum compressor run time between instances of defrost cycle type i in hours rounded to the nearest tenth of an hour (greater than CT_{Li} but not more than 96 hours);

For cases in which there are more than one fixed CT value (for long-time defrost models) or more than one CT_M and/or CT_L value (for variable defrost models) for a given defrost cycle type, an average fixed CT value or average CT_M and CT_L values shall be selected for this cycle type so that 12 divided by this value or values is the frequency of occurrence of the defrost cycle type in a 24 hour period, assuming 50% compressor run time.

F = default defrost energy consumption factor, equal to 0.20.

For variable defrost models with no values for CT_{Li} and CT_{Mi} in the algorithm, the default values of 6 and 96 shall be used, respectively.

D is the total number of distinct defrost cycle types.

5.3 Volume Measurements. The electric refrigerator or electric refrigerator-freezer total refrigerated volume, VT, shall be measured in accordance with HRF–1–2008, (incorporated by reference; see §430.3), section 3.30 and sections 4.2 through 4.3, and be calculated equivalent to:

$$VT = VF + VFF$$

Where:

VT = total refrigerated volume in cubic feet,
VF = freezer compartment volume in cubic feet, and
VFF = fresh food compartment volume in cubic feet.

In the case of refrigerators or refrigerator-freezers with automatic icemakers, the volume occupied by the automatic icemaker, including its ice storage bin, is to be included in the volume measurement.

5.4 Externally Vented Refrigerator or Refrigerator-Freezer Units. All test measurements for the externally vented refrigerator or refrigerator-freezer shall be made in accordance with the requirements of other sections of this appendix, except as modified in this section or other sections expressly applicable to externally vented refrigerators or refrigerator-freezers.

5.4.1 Operability of ''Thermostatic'' and ''Mixing of Air'' Controls. Before conducting energy consumption tests, the operability of thermostatic controls that permit the mixing of exterior and ambient air when exterior air temperatures are less than 60 °F (15.6 °C) must be verified. The operability of such controls shall be verified by operating the unit under ambient air temperature of 90 °F (32.2 °C) and exterior air temperature of 45 °F (7.2 °C). If the inlet air entering the condenser or condenser/compressor compartment is maintained at 60 ±3 °F (15.6 ±1.7 °C), energy consumption of the unit shall be measured under 5.4.2.2 and 5.4.2.3. If the inlet air entering the condenser or condenser/compressor compartment is not maintained at 60 ±3 °F (15.6 ±1.7 °C), energy consumption of the unit shall also be measured under 5.4.2.4.

5.4.2 Energy Consumption Tests.

5.4.2.1 Correction Factor Test. To enable calculation of a correction factor, K, two full cycle tests shall be conducted to measure energy consumption of the unit with air mixing controls disabled and the condenser inlet air temperatures set at 90 °F (32.2 °C) and 80 °F (26.7 °C). Both tests shall be conducted with all compartment temperature controls set at the position midway between their warmest and coldest settings and the anti-sweat heater switch off. Record the energy consumptions ec_{90} and ec_{80}, in kWh/day.

5.4.2.2 Energy Consumption at 90 °F. The unit shall be tested at 90 °F (32.2 °C) exterior air temperature to record the energy consumptions $(e_{90})_i$ in kWh/day. For a given setting of the anti-sweat heater, the value i corresponds to each of the two states of the compartment temperature control positions.

5.4.2.3 Energy Consumption at 60 °F. The unit shall be tested at 60 °F (26.7 °C) exterior air temperature to record the energy consumptions $(e_{60})_i$ in kWh/day. For a given setting of the anti-sweat heater, the value i corresponds to each of the two states of the compartment temperature control positions.

5.4.2.4 Energy Consumption if Mixing Controls do not Operate Properly. If the operability of temperature and mixing controls has not been verified as required under 5.4.1, the unit shall be tested at 50 °F (10.0 °C) and 30 °F (-1.1 °C) exterior air temperatures to record the energy consumptions $(e_{50})_i$ and $(e_{30})_i$. For a given setting of the anti-sweat heater, the value i corresponds to each of the two states of the compartment temperature control positions.

6. Calculation of Derived Results From Test Measurements

6.1 Adjusted Total Volume.

6.1.1 Electric Refrigerators. The adjusted total volume, VA, for electric refrigerators under test shall be defined as:

$$VA = (VF \times CR) + VFF$$

Where:

VA = adjusted total volume in cubic feet;
VF and VFF are defined in 5.3; and
CR = dimensionless adjustment factor of 1.47 for refrigerators other than all-refrigerators, or 1.0 for all-refrigerators.

6.1.2 Electric Refrigerator-Freezers. The adjusted total volume, VA, for electric refrigerator-freezers under test shall be calculated as follows:

$$VA = (VF \times CRF) + VFF$$

Where:

VF and VFF are defined in 5.3 and VA is defined in 6.1.1, and
CRF = dimensionless adjustment factor of 1.76.

6.2 Average Per-Cycle Energy Consumption.

6.2.1 All-Refrigerator Models. The average per-cycle energy consumption for a cycle type, E, is expressed in kilowatt-hours per cycle to the nearest one hundredth (0.01) kilowatt-hour and shall depend upon the temperature attainable in the fresh food compartment as shown below.

6.2.1.1 If the fresh food compartment temperature is always below 39.0 °F (3.9 °C), the average per-cycle energy consumption shall be equivalent to:

E = ET1

Where:

ET is defined in 5.2.1; and

The number 1 indicates the test period during which the highest fresh food compartment temperature is measured.

6.2.1.2 If one of the fresh food compartment temperatures measured for a test period is greater than 39.0 °F (3.9 °C), the average per-cycle energy consumption shall be equivalent to:

$E = ET1 + ((ET2 - ET1) \times (39.0 - TR1)/(TR2 - TR1))$

Where:

ET is defined in 5.2.1;

TR = fresh food compartment temperature determined according to 5.1.3 in degrees F;

The numbers 1 and 2 indicate measurements taken during the first and second test period as appropriate; and

39.0 = standardized fresh food compartment temperature in degrees F.

6.2.2 Refrigerators and Refrigerator-Freezers. The average per-cycle energy consumption for a cycle type, E, is expressed in kilowatt-hours per-cycle to the nearest one hundredth (0.01) kilowatt-hour and shall be defined in one of the following ways as applicable.

6.2.2.1 If the fresh food compartment temperature is at or below 39 °F (3.9 °C) in both tests and the freezer compartment temperature is at or below 15 °F (-9.4 °C) in both tests of a refrigerator or at or below 0 °F (-17.8 °C) in both tests of a refrigerator-freezer, the per-cycle energy consumption shall be:

E = ET1 + IET

Where:

ET is defined in 5.2.1;

IET, expressed in kilowatt-hours per cycle, equals 0.23 for a product with an automatic icemaker and otherwise equals 0 (zero); and

The number 1 indicates the test period during which the highest freezer compartment temperature was measured.

6.2.2.2 If the conditions of 6.2.2.1 do not exist, the per-cycle energy consumption shall be defined by the higher of the two values calculated by the following two formulas:

$E = ET1 + ((ET2 - ET1) \times (39.0 - TR1)/(TR2 - TR1)) + IET$

and

$E = ET1 + ((ET2 - ET1) \times (k - TF1)/(TF2 - TF1)) + IET$

Where:

E is defined in 6.2.1.1;

ET is defined in 5.2.1;

IET is defined in 6.2.2.1;

TR and the numbers 1 and 2 are defined in 6.2.1.2;

TF = freezer compartment temperature determined according to 5.1.4 in degrees F;

39.0 is a specified fresh food compartment temperature in degrees F; and

k is a constant 15.0 for refrigerators or 0.0 for refrigerator-freezers, each being standardized freezer compartment temperatures in degrees F.

6.2.3 Variable Anti-Sweat Heater Models. The standard cycle energy consumption of an electric refrigerator-freezer with a variable anti-sweat heater control (E_{std}), expressed in kilowatt-hours per day, shall be calculated equivalent to:

E_{std} = E + (Correction Factor) where E is determined by 6.2.1.1, 6.2.1.2, 6.2.2.1, or 6.2.2.2, whichever is appropriate, with the anti-sweat heater switch in the ''off'' position or, for a product without an anti-sweat heater switch, the anti-sweat heater in its lowest energy use state.

Correction Factor = (Anti-sweat Heater Power $\times$ System-loss Factor) $\times$ (24 hrs/1 day) $\times$ (1 kW/1000 W)

Where:

Anti-sweat Heater Power = 0.034 * (Heater Watts at 5%RH)
+ 0.211 * (Heater Watts at 15%RH)
+ 0.204 * (Heater Watts at 25%RH)
+ 0.166 * (Heater Watts at 35%RH)
+ 0.126 * (Heater Watts at 45%RH)
+ 0.119 * (Heater Watts at 55%RH)
+ 0.069 * (Heater Watts at 65%RH)
+ 0.047 * (Heater Watts at 75%RH)
+ 0.008 * (Heater Watts at 85%RH)
+ 0.015 * (Heater Watts at 95%RH)

Heater Watts at a specific relative humidity = the nominal watts used by all heaters at that specific relative humidity, 72 °F (22.2 °C) ambient, and DOE reference temperatures of fresh food (FF) average temperature of 39 °F (3.9 °C) and freezer (FZ) average temperature of 0 °F (−17.8 °C).

System-loss Factor = 1.3.

6.3 Externally vented refrigerator or refrigerator-freezers. Per-cycle energy consumption measurements for an externally vented refrigerator or refrigerator-freezer shall be calculated in accordance with the requirements of this appendix, as modified in sections 6.3.1–6.3.7.

6.3.1 Correction Factor. The correction factor, K, shall be calculated as:

$K = ec_{90}/ec_{80}$

Where:

ec_{90} and ec_{80} are measured in section 5.4.2.1.

6.3.2 Combining Test Results of Different Settings of Compartment Temperature Controls. For a given setting of the anti-sweat heater, follow the calculation procedures of 6.2 to combine the test results for energy consumption of the unit at different temperature control settings for each condenser inlet air temperature tested under 5.4.2.2, 5.4.2.3, and 5.4.2.4, where applicable, $(e_{90})_i$, $(e_{60})_i$, $(e_{50})_i$, and $(e_{30})_i$. The combined values, $_{90}$, $_{60}$, $_{50}$, and $_{30}$, where applicable, are expressed in kWh/day.

6.3.3 Energy Consumption Corrections. For a given setting of the anti-sweat heater, adjust the energy consumptions $_{90}$, $_{60}$, $_{50}$, and $_{30}$ calculated in 6.3.2 by multiplying the correction factor K to obtain the corrected energy consumptions per day in kWh/day:

$E_{90} = K \times {}_{90,}$
$E_{60} = K \times {}_{60,}$
$E_{50} = K \times {}_{50}$, and
$E_{30} = K \times {}_{30}$

Where:

K is determined under section 6.3.1; and $_{90}$, $_{60}$, $_{50}$, and $_{30}$ are determined under section 6.3.2.

6.3.4 Energy Profile Equation. For a given setting of the anti-sweat heater, calculate the energy consumption E_X, in kWh/day, at a specific exterior air temperature between 80 °F (26.7 °C) and 60 °F (26.7 °C) using the following equation:

$E_X = E_{60} + (E_{90} - E_{60}) \times (T_X - 60)/30$

Where:

T_X is the exterior air temperature in °F;
60 is the exterior air temperature in °F for the test of section 5.4.2.3;
30 is the difference between 90 and 60;
E_{60} and E_{90} are determined in section 6.3.3.

6.3.5 Energy Consumption at 80 °F (26.7 °C), 75 °F (23.9 °C) and 65 °F (18.3 °C). For a given setting of the anti-sweat heater, calculate the energy consumptions at 80 °F (26.7 °C), 75 °F (23.9 °C) and 65 °F (18.3 °C) exterior air temperatures, E_{80}, E_{75} and E_{65}, respectively, in kWh/day, using the equation in 6.3.4.

6.3.6 National Average Per-Cycle Energy Consumption. For a given setting of the anti-sweat heater, calculate the national average energy consumption, E_N, in kWh/day, using one of the following equations:

$E_N = 0.523 \times E_{60} + 0.165 \times E_{65} + 0.181 \times E_{75} + 0.131 \times E_{80}$, for units not tested under section 5.4.2.4; and

$E_N = 0.257 \times E_{30} + 0.266 \times E_{50} + 0.165 \times E_{65} + 0.181 \times E_{75} + 0.131 \times E_{80}$, for units tested under section 5.4.2.4

Where:

E_{30}, E_{50}, and E_{60} are defined in 6.3.3;
E_{65}, E_{75}, and E_{80} are defined in 6.3.5;
and
the coefficients 0.523, 0.165, 0.181, 0.131, 0.257 and 0.266 are weather-associated weighting factors.

6.3.7 Regional Average Per-Cycle Energy Consumption. If regional average per-cycle energy consumption is required to be calculated for a given setting of the anti-sweat heater, calculate the regional average per-cycle energy consumption, E_R, in kWh/day, for the regions in Figure 3. Use one of the following equations and the coefficients in Table A:

$E_R = a_1 \times E_{60} + c \times E_{65} + d \times E_{75} + e \times E_{80}$, for a unit that is not required to be tested under section 5.4.2.4; or

$E_R = a \times E_{30} + b \times E_{50} + c \times E_{65} + d \times E_{75} + e \times E_{80}$, for a unit tested under section 5.4.2.4

Where:

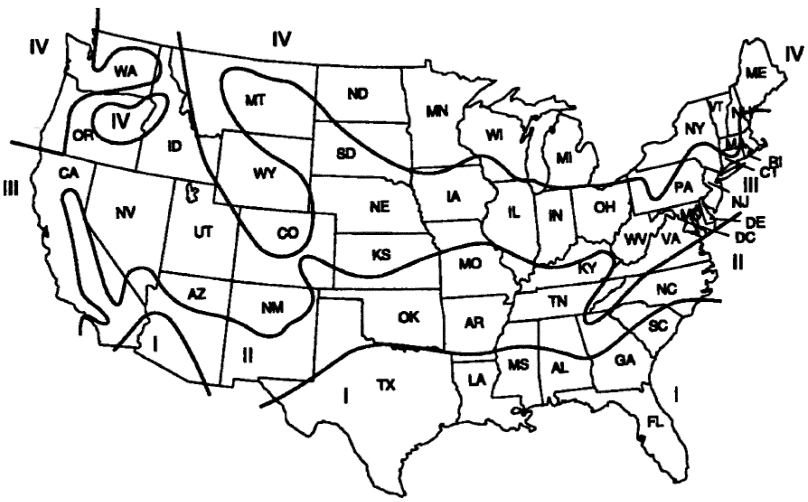
E_{30}, E_{50}, and E_{60} are defined in section 6.3.3;
E_{65}, E_{75}, and E_{80} are defined in section 6.3.5; and
a_1, a, b, c, d, and e are weather-associated weighting factors for the regions, as specified in Table A.

TABLE A—COEFFICIENTS FOR CALCULATING REGIONAL AVERAGE PER-CYCLE ENERGY CONSUMPTION

[Weighting factors]

Regions	a1	a	b	c	d	e
I	0.282	0.039	0.244	0.194	0.326	0.198
II	0.486	0.194	0.293	0.191	0.193	0.129
III	0.584	0.302	0.282	0.178	0.159	0.079
IV	0.664	0.420	0.244	0.161	0.121	0.055

Figure 3: Weather Regions for the United States



Alaska: Region IV

Hawaii: Region I

7. Test Procedure Waivers

To the extent that the procedures contained in this appendix do not provide a means for determining the energy consumption of a refrigerator or refrigerator-freezer, a manufacturer must obtain a waiver under 10 CFR 430.27 to establish an acceptable test procedure for each such product. Such instances could, for example, include situations where the test set-up for a particular refrigerator or refrigerator-freezer basic model is not clearly defined by the provisions of section 2. For details regarding the criteria and procedures for obtaining a waiver, please refer to 10 CFR 430.27.

[75 FR 78851, Dec. 16, 2010, as amended at 76 FR 12502, Mar. 7, 2011; 76 FR 24781, May 2, 2011; 77 FR 3574, Jan. 25, 2012]

APPENDIX A1 TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF ELECTRIC REFRIGERATORS AND ELECTRIC REFRIGERATOR-FREEZERS

The provisions of appendix A1 shall apply to all products manufactured prior to the effective date of any amended standards promulgated by DOE pursuant to Section 325(b)(4) of the Energy Policy and Conservation Act of 1975, as amended by the Energy Independence and Security Act of 2007 (to be codified at 42 U.S.C. 6295(b)(4)).

1. Definitions

Section 3, *Definitions*, of HRF–1–1979 (incorporated by reference; see §430.3) applies to this test procedure.

1.1 ''Adjusted total volume'' means the sum of (i) the fresh food compartment volume as defined in HRF–1–1979 in cubic feet, and (ii) the product of an adjustment factor and the net freezer compartment volume as defined in HRF–1–1979, in cubic feet.

1.2 ''All-refrigerator'' means an electric refrigerator which does not include a compartment for the freezing and long time storage of food at temperatures below 32 °F (0.0 °C). It may include a compartment of 0.50 cubic feet capacity (14.2 liters) or less for the freezing and storage of ice.

1.3 ''Anti-sweat heater'' means a device incorporated into the design of a refrigerator or refrigerator-freezer to prevent the accumulation of moisture on exterior or interior surfaces of the cabinet.

1.4 ''Anti-sweat heater switch'' means a user-controllable switch or user interface which modifies the activation or control of anti-sweat heaters.